

# **ESC201T : Introduction to Electronics**

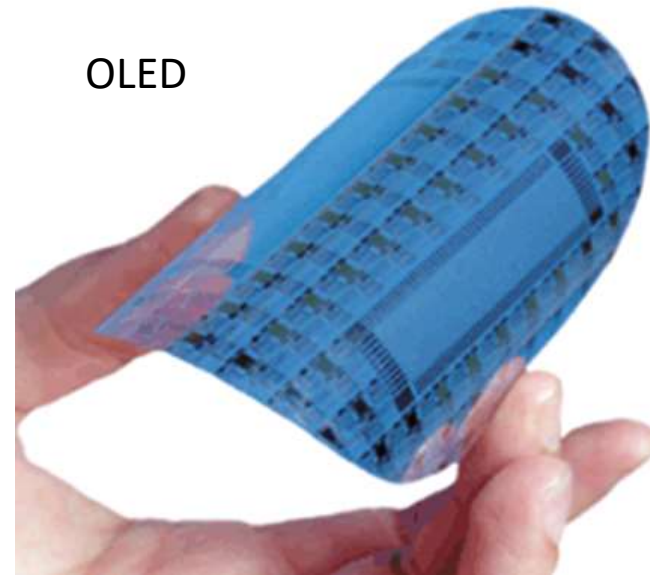
## **L12: Capacitors and Displays**

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“Watching of Images and Videos on mobile or TV is not possible without capacitors”



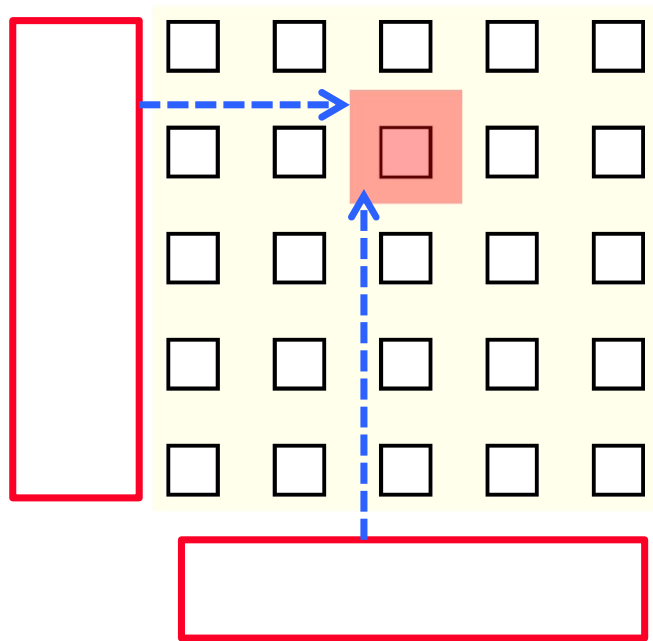
Liquid crystal cells can be looked upon as Voltage controlled light valves.



Organic light emitting diodes emit light upon application of current as a result of electron-hole recombination

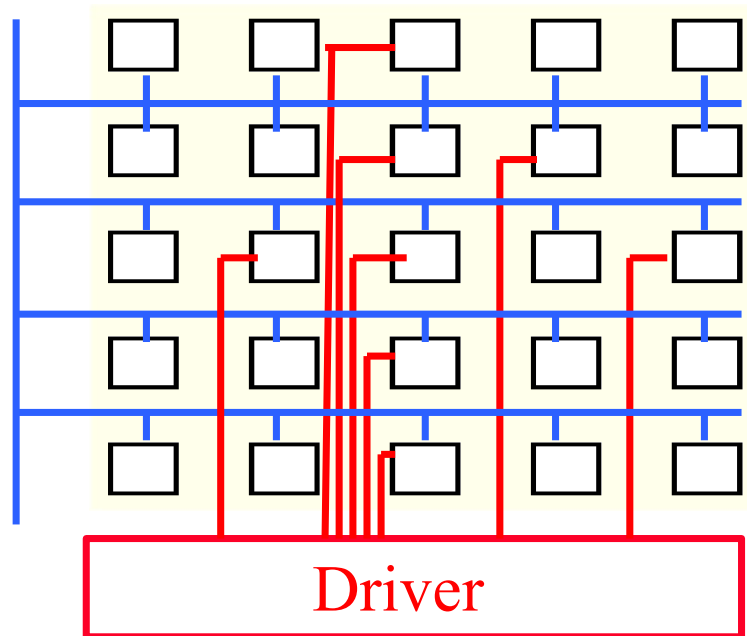
Image is created by controlling amount and color of light coming out from different regions of the screen

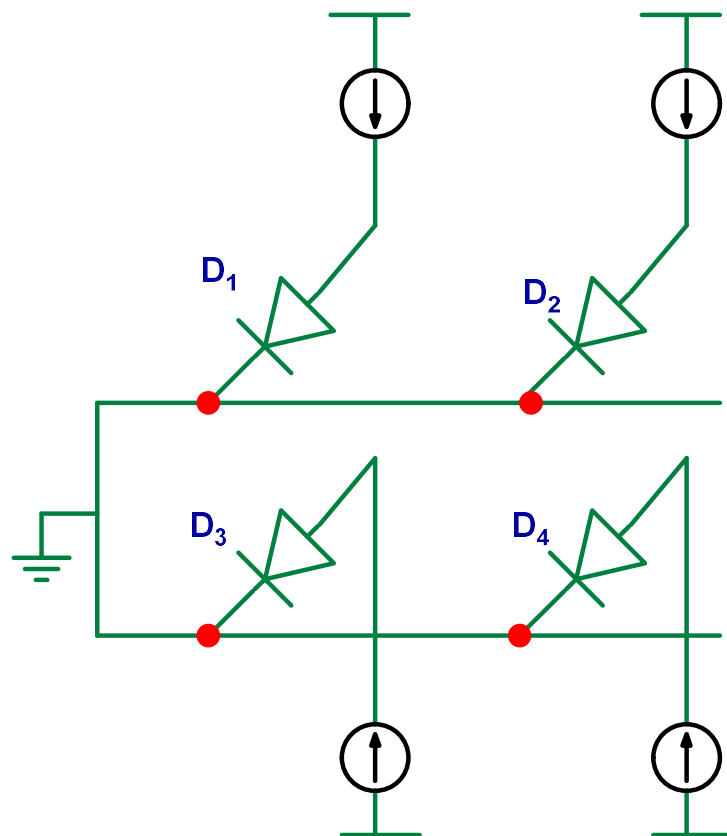
**Display elements (such as OLED) have to be selectively turned ON/OFF to create an image**

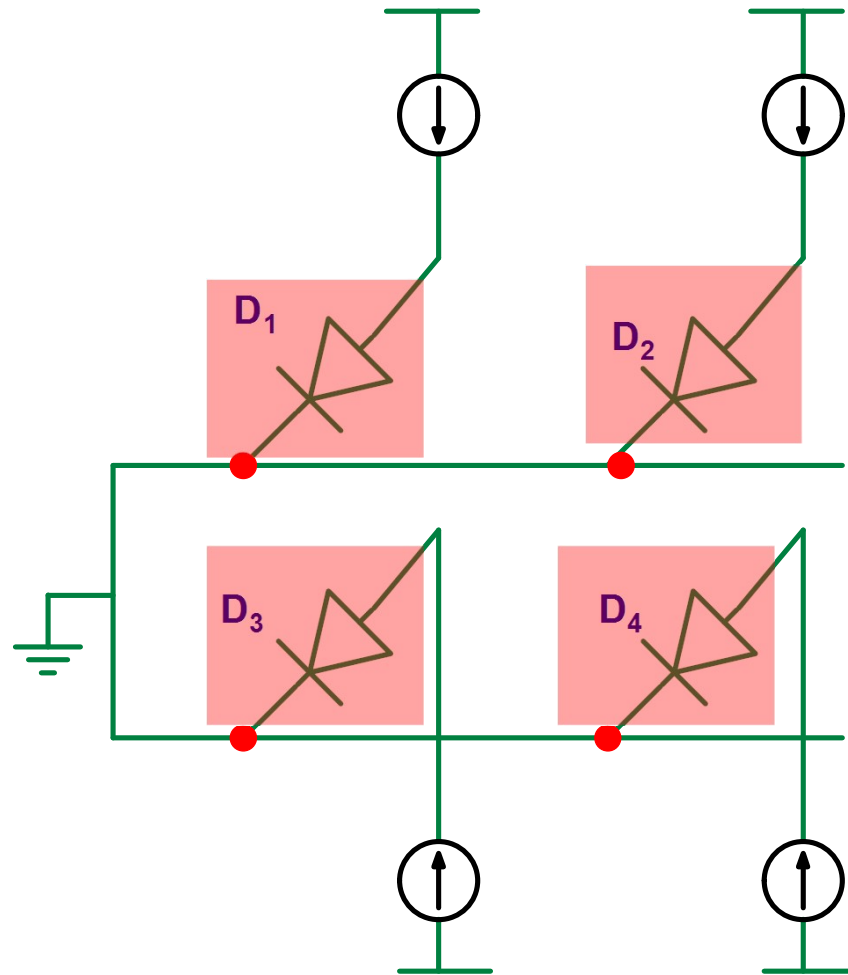


- Direct addressing
- Passive Matrix addressing
- Active Matrix addressing

- ❑ In **direct addressing** , each OLED (or pixel) has its own dedicated connection to external driver.

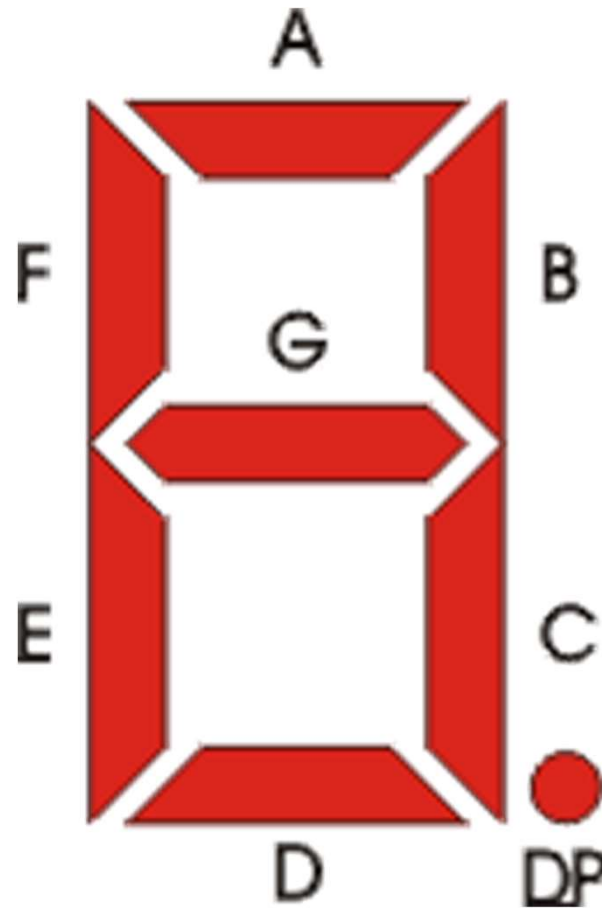




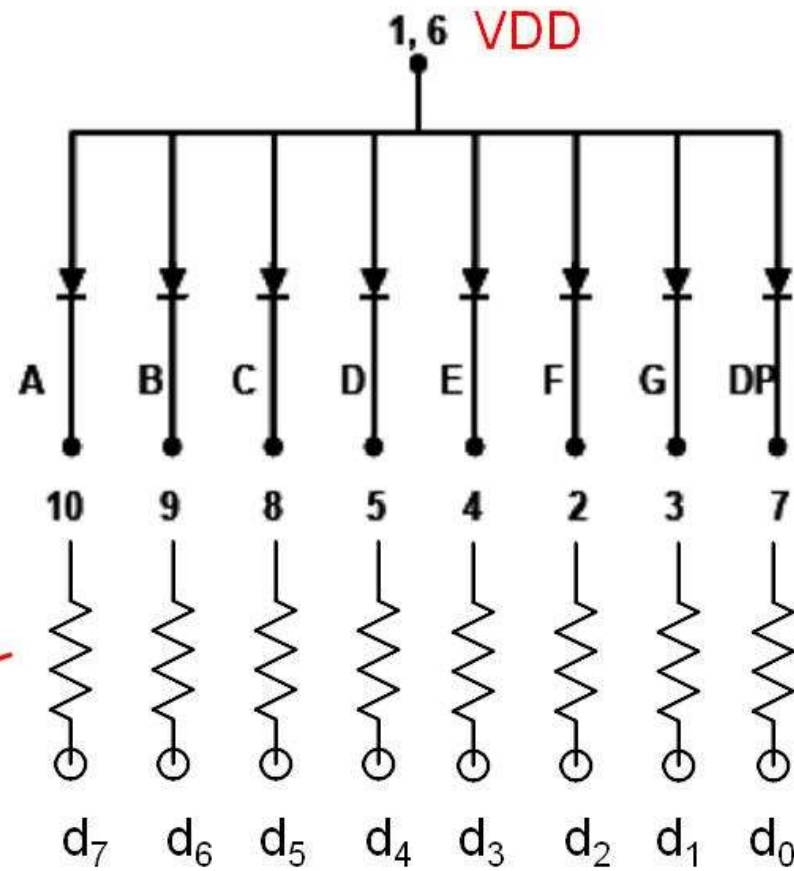
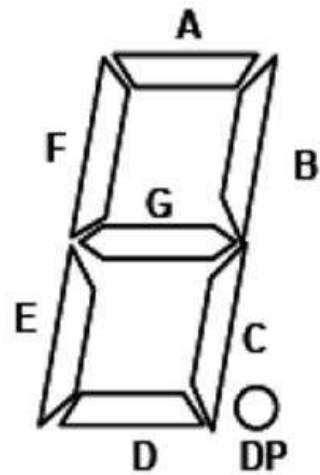


Freedom to turn-on any combination of LEDs and to any level of brightness

## Example of Direct Addressing: Seven segment Display

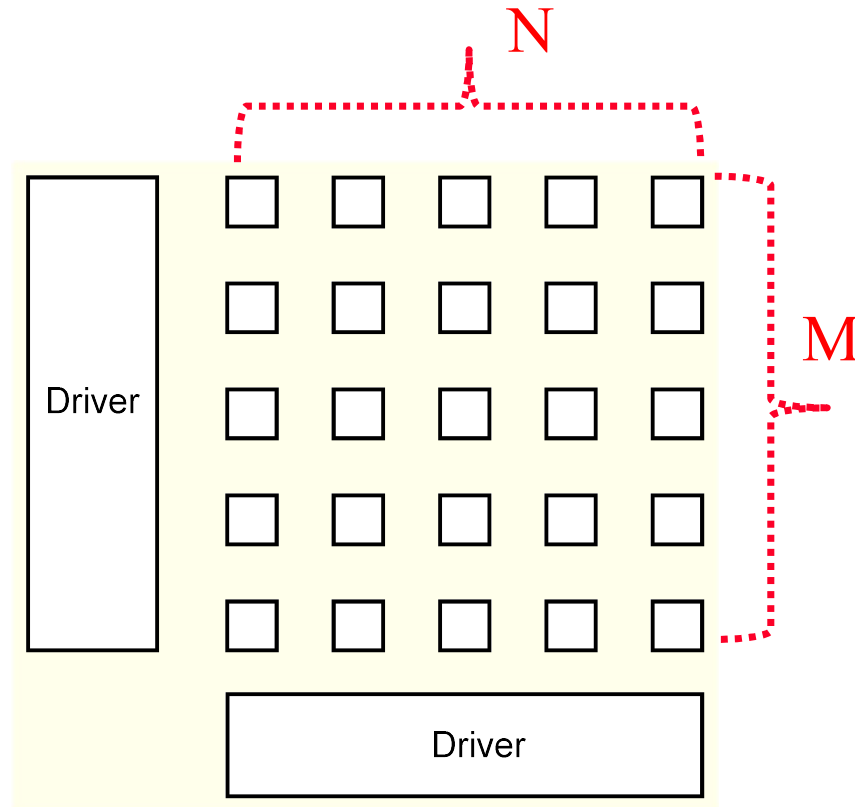






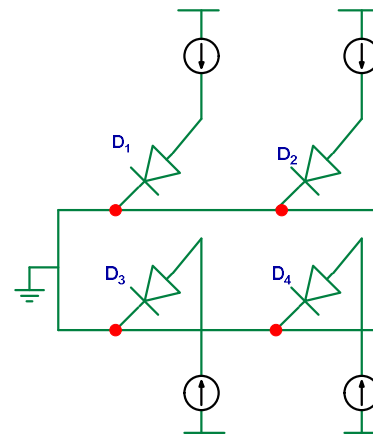
220 $\Omega$  for ~13mA current

# Problem

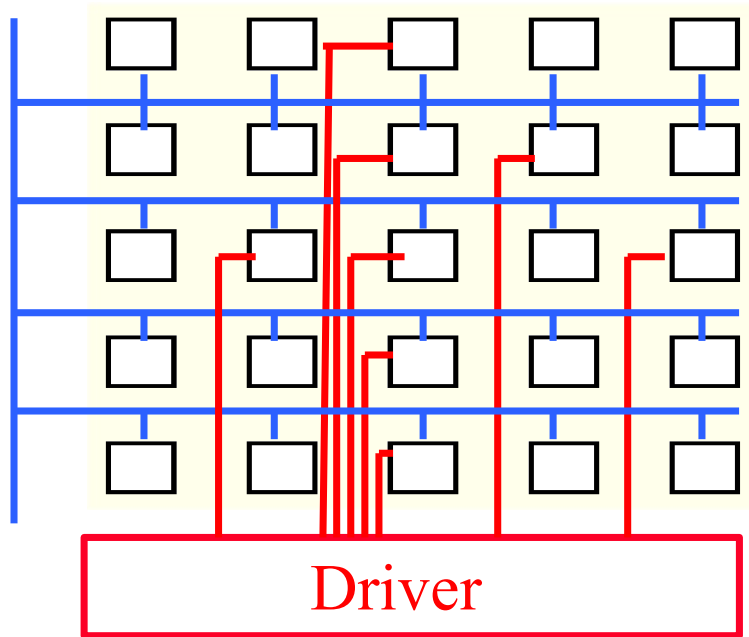


$$\text{No. of drivers} = M \times N$$

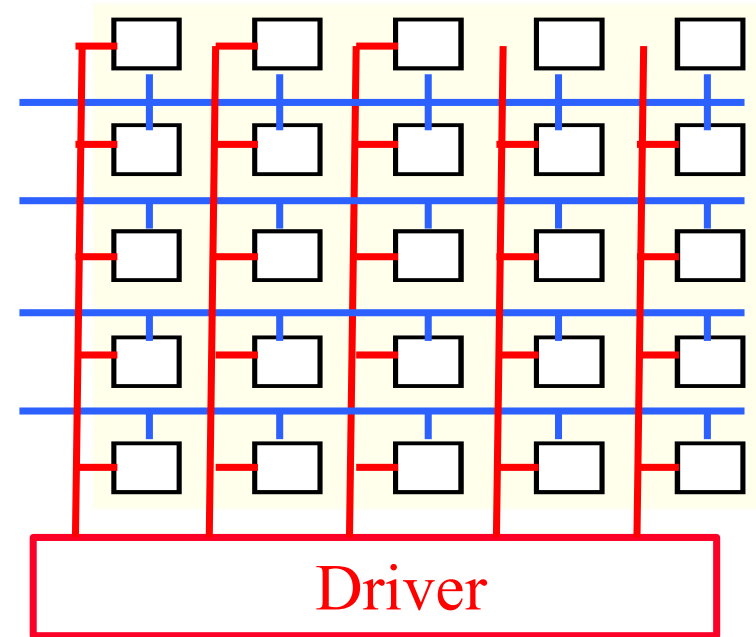
- For a 1080 x 1920 FHD color display, No. of drivers required =  $6.2 \times 10^6$  !



# Matrix Addressed Display

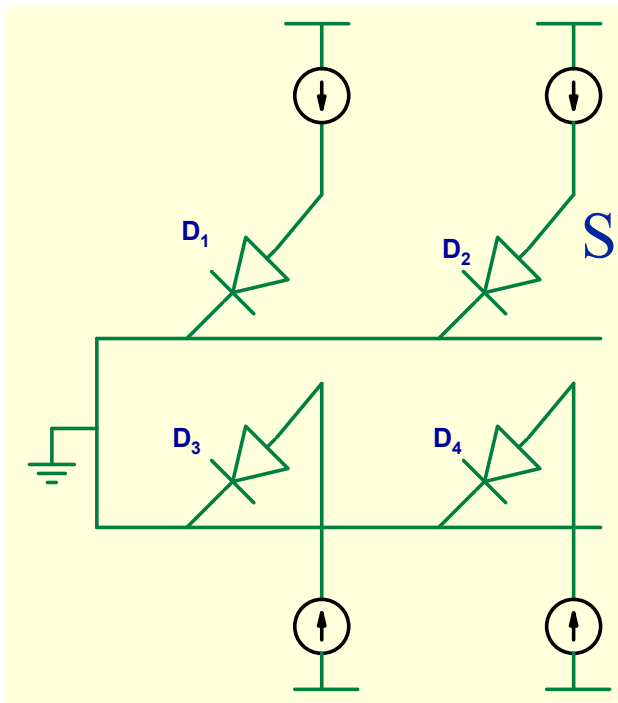


25 drivers and wires

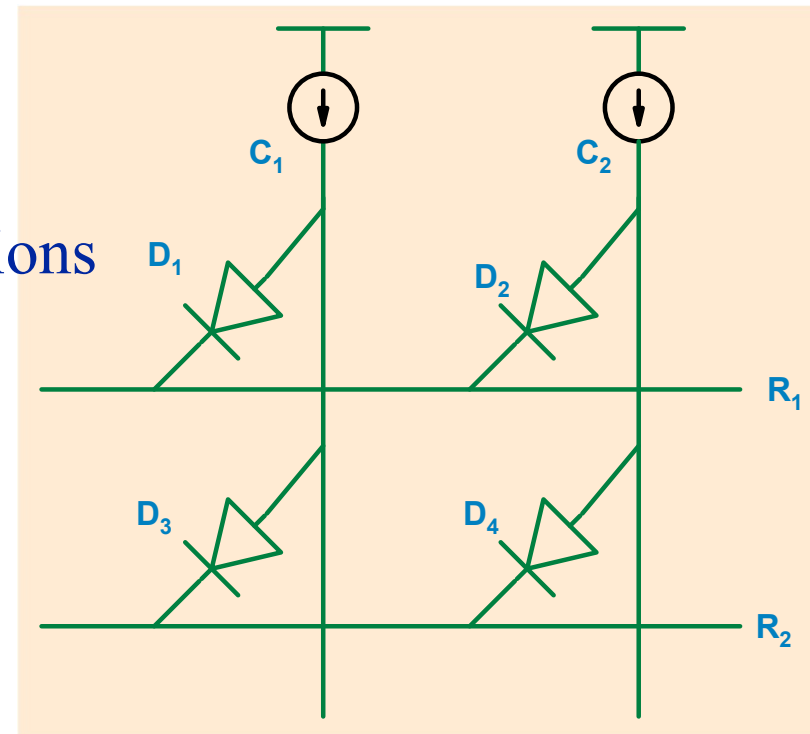


10 drivers & wires

# Matrix Addressed Display



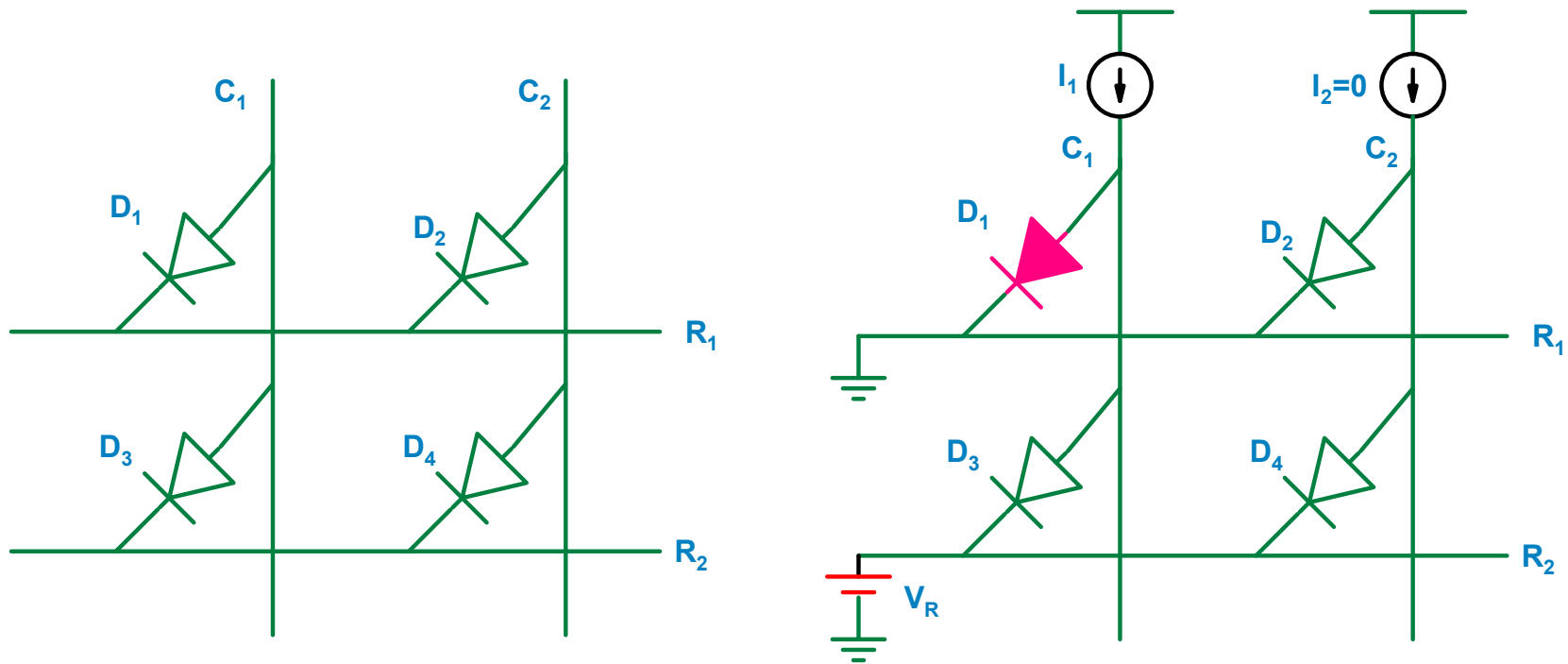
Share connections



No. of drivers =  $M \times N$

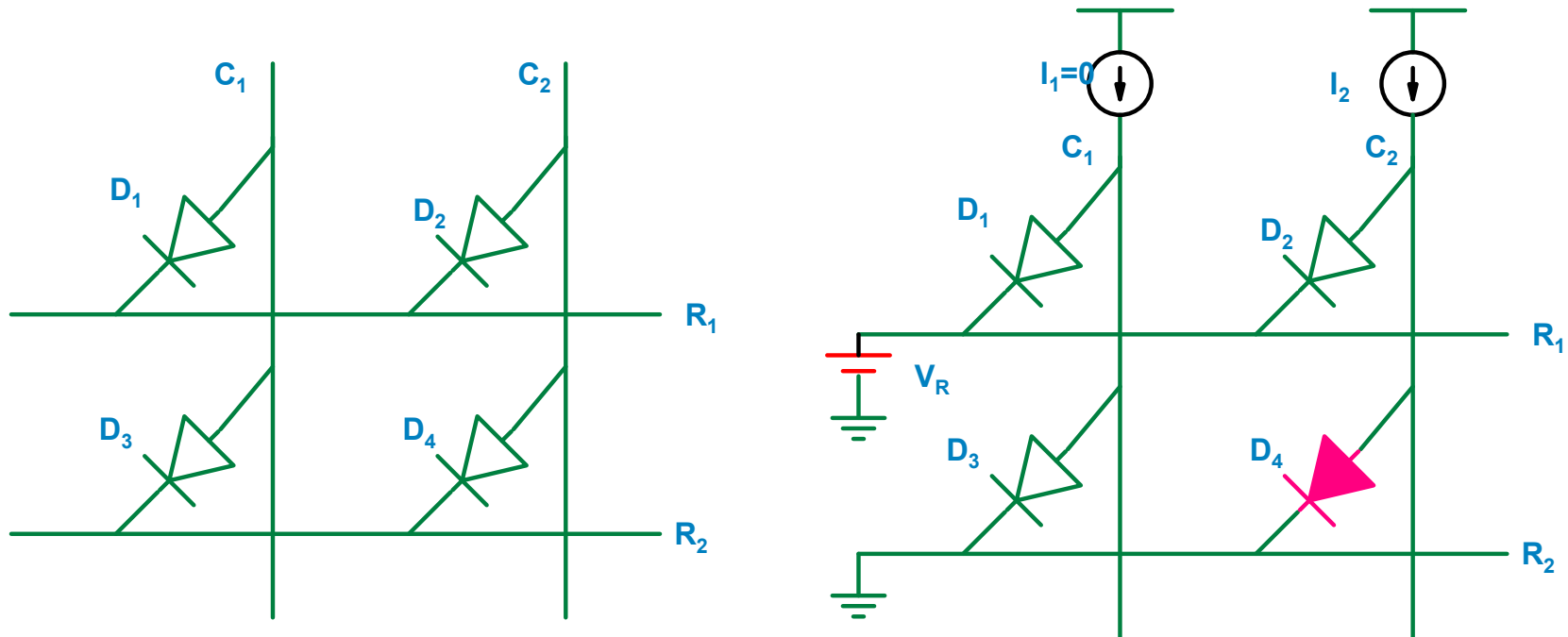
No. of drivers =  $M+N$

Suppose  $D_1$  has to be turned ON only !



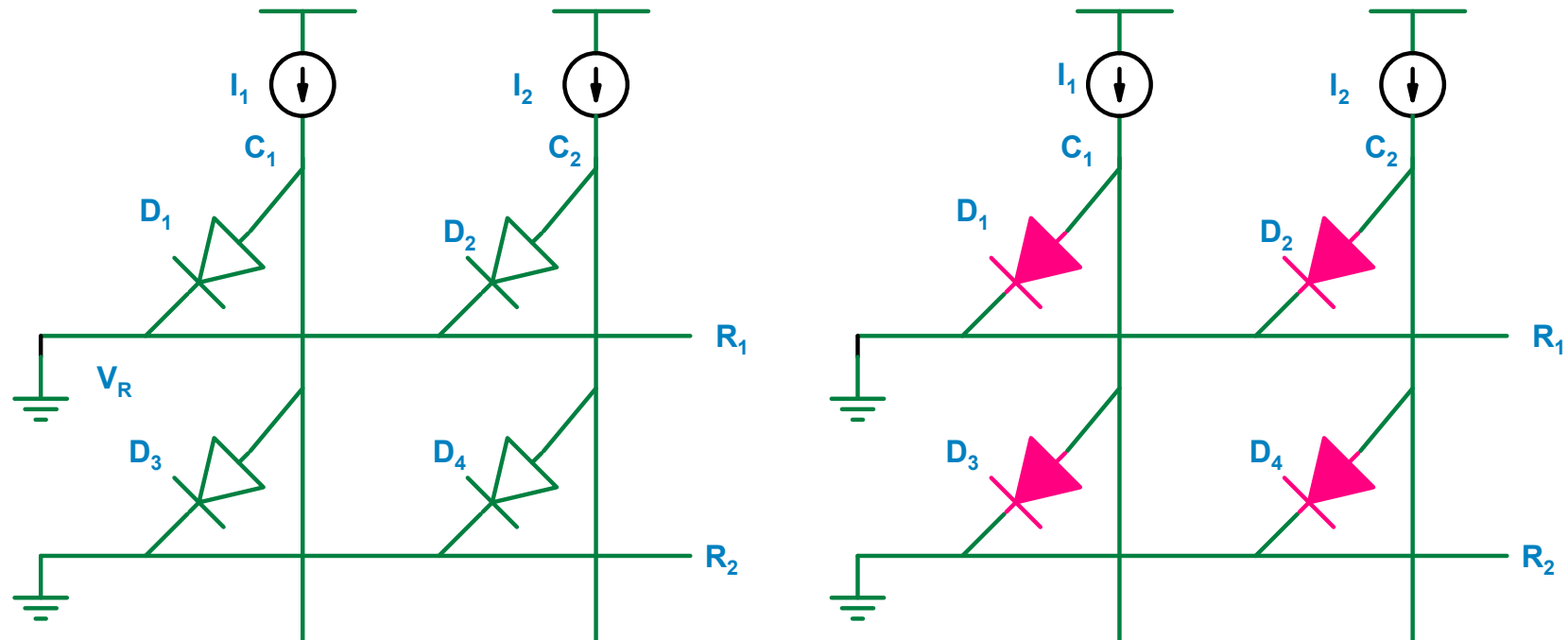
Current does not flow through  $D_3$  because it is reverse biased

Suppose  $D_4$  has to be turned ON only !



Current does not flow through  $D_2$  because it is reverse biased

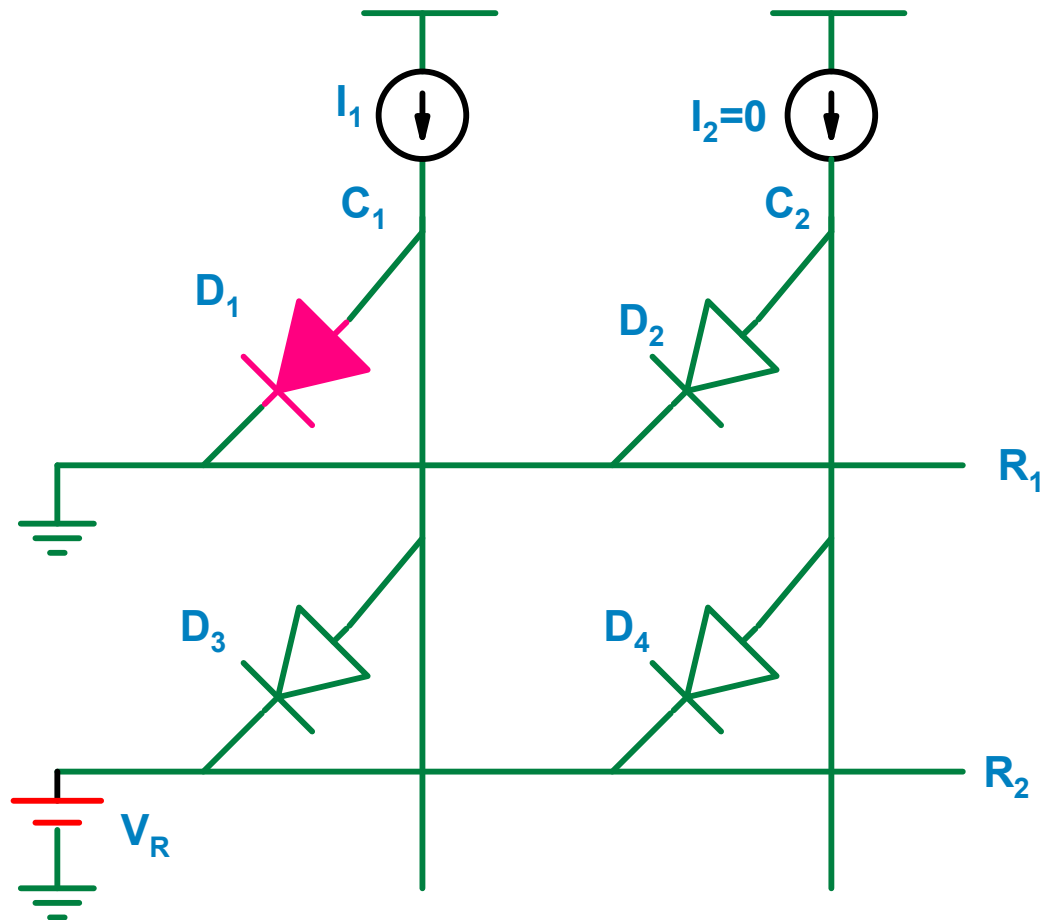
Suppose both  $D_1$  and  $D_4$  have to be turned ON



All four LEDS turn ON.

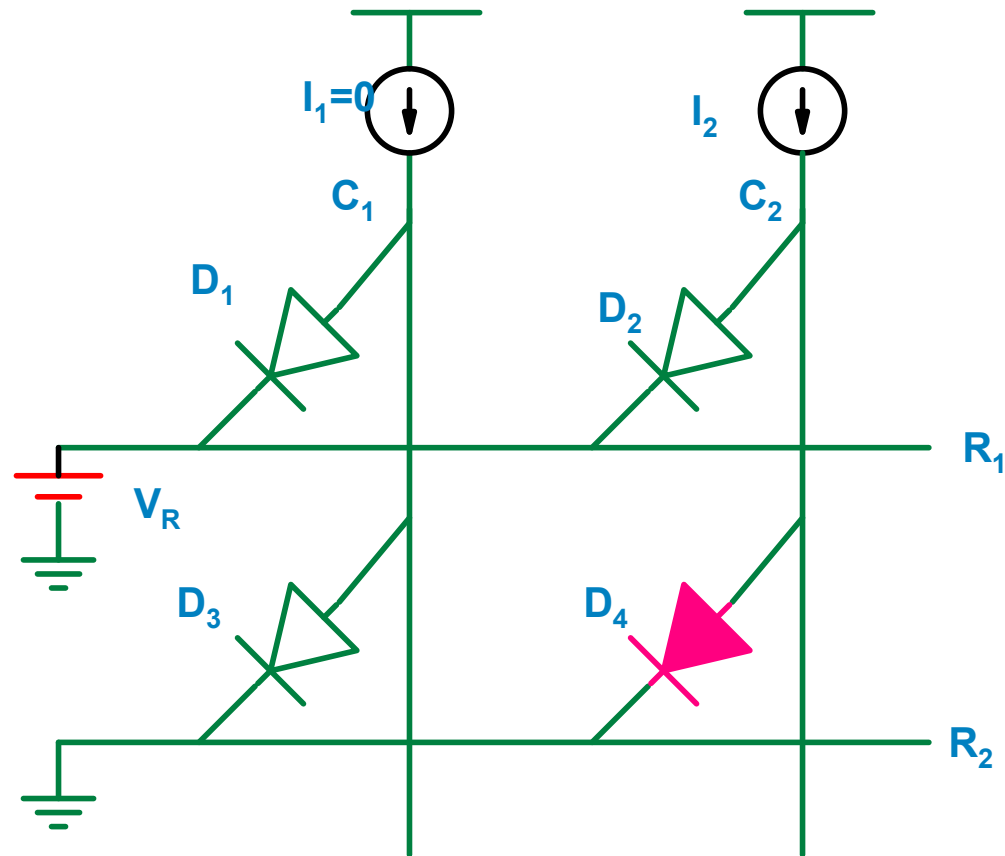
Two errors:  $D_2$  and  $D_3$  are On when they should be OFF  
Brightness of  $D_1$  and  $D_4$  is halved because current is divided

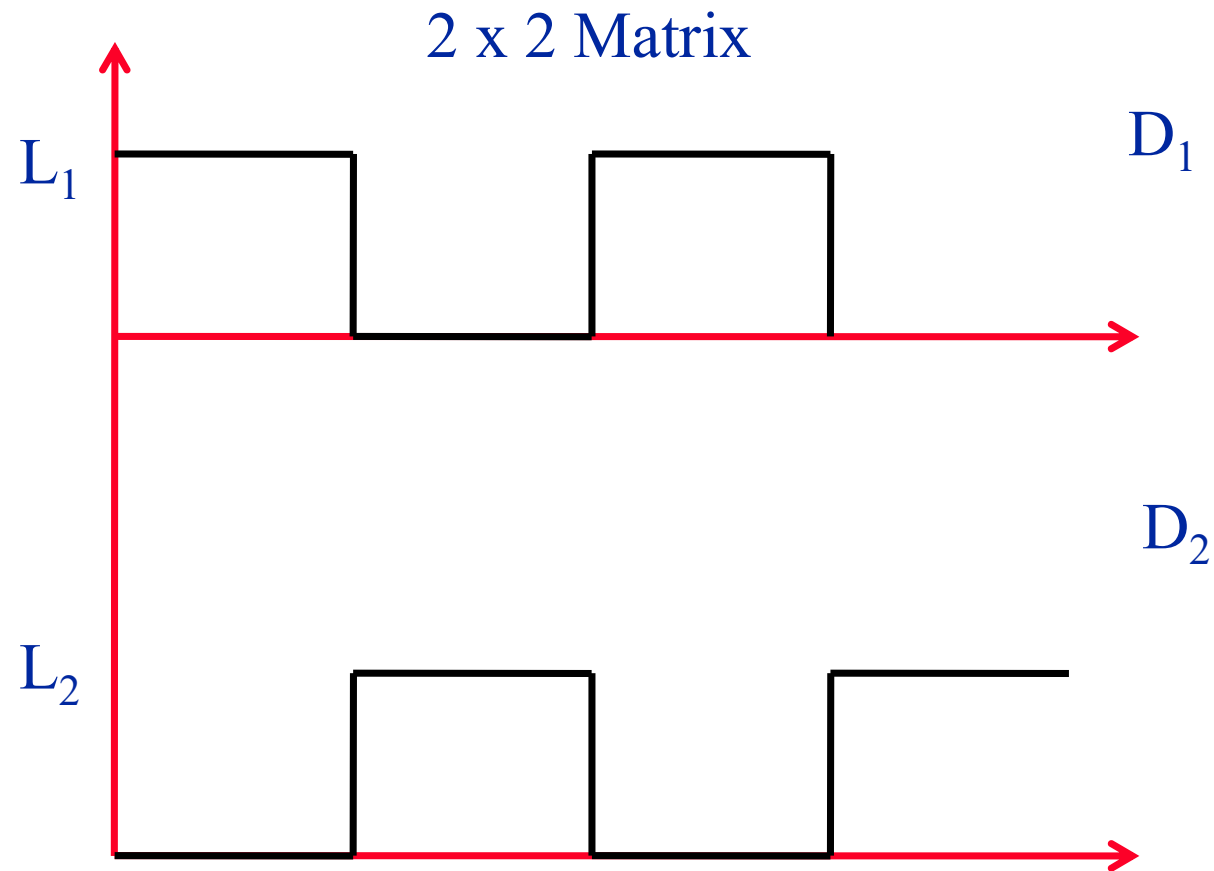
**Solution:** Data can be displayed row by row





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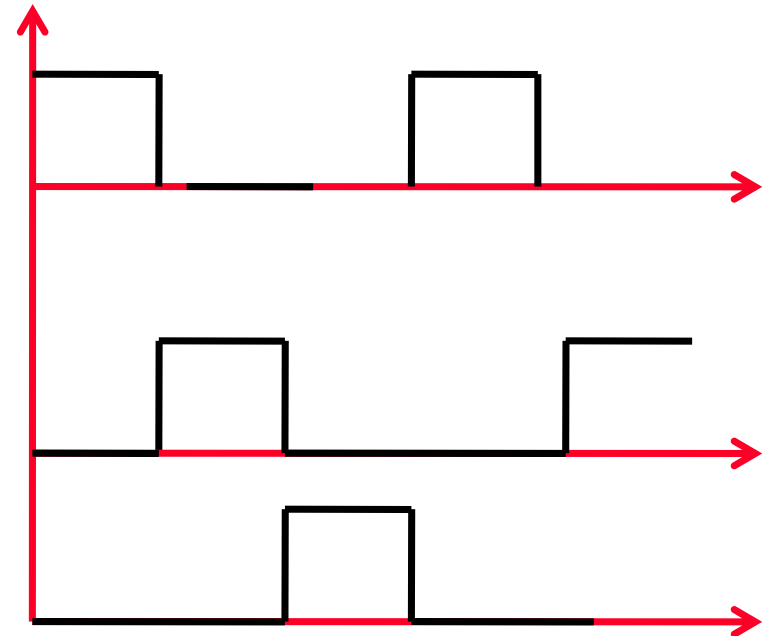
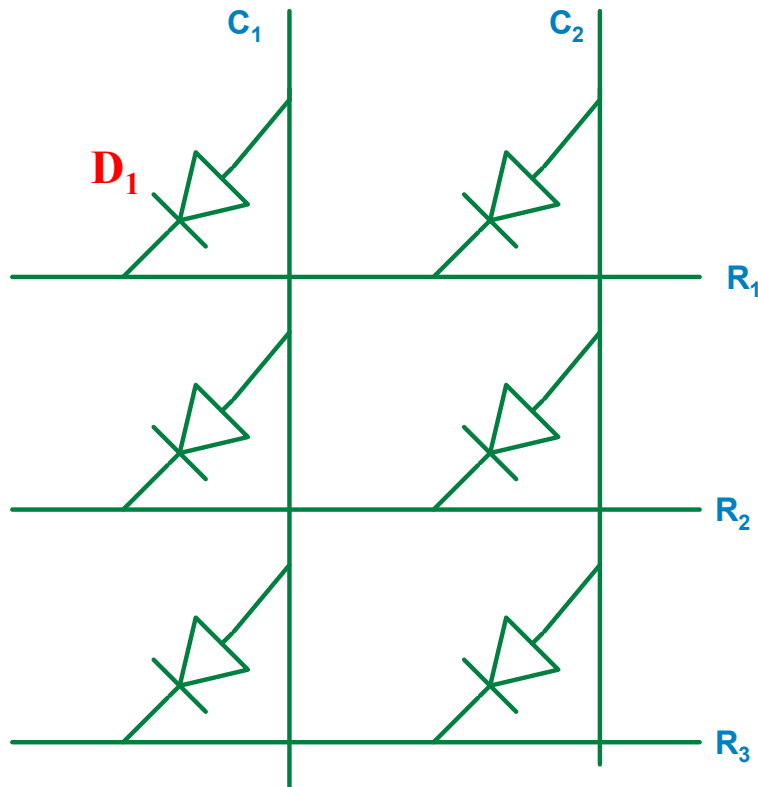




Average Brightness of two LEDs will be  $0.5L_1$  and  $0.5L_2$

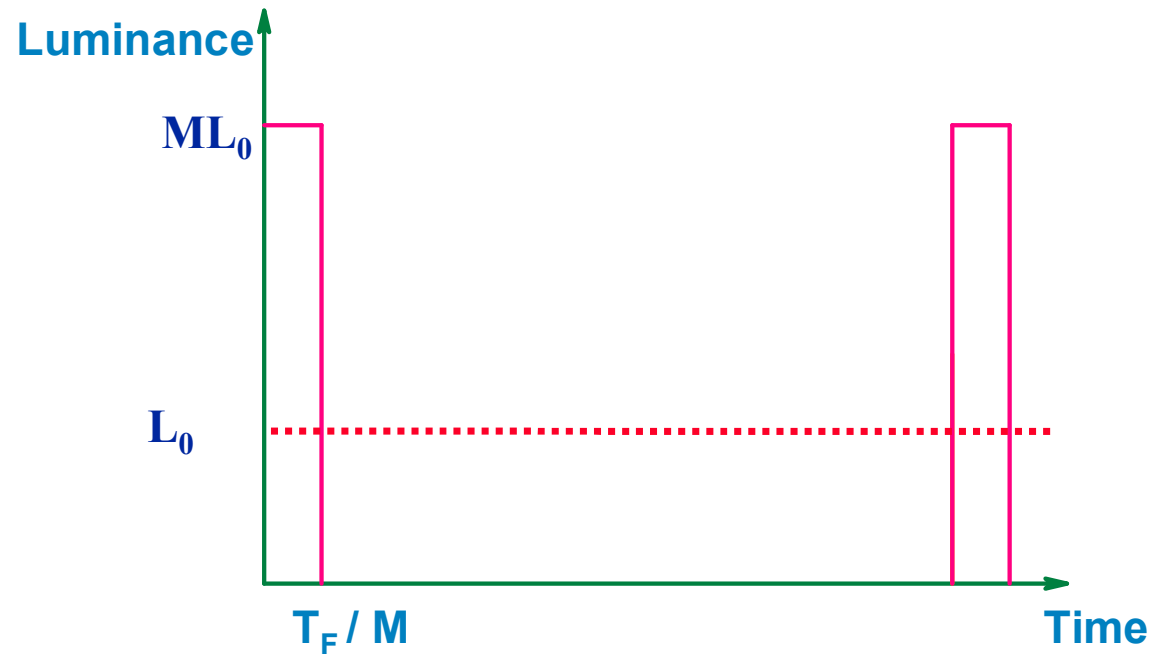
If we want average brightness of 100, then LEDs must be illuminated to a brightness of  $200 \text{ Cd/m}^2$

What about matrix with 3 rows and 2 columns (2 x 3)?



Average brightness is 1/3 of peak brightness

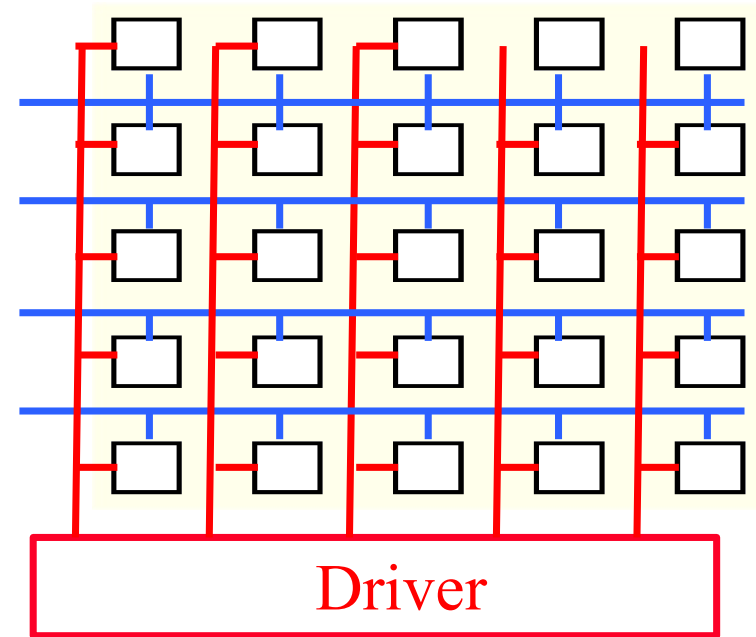
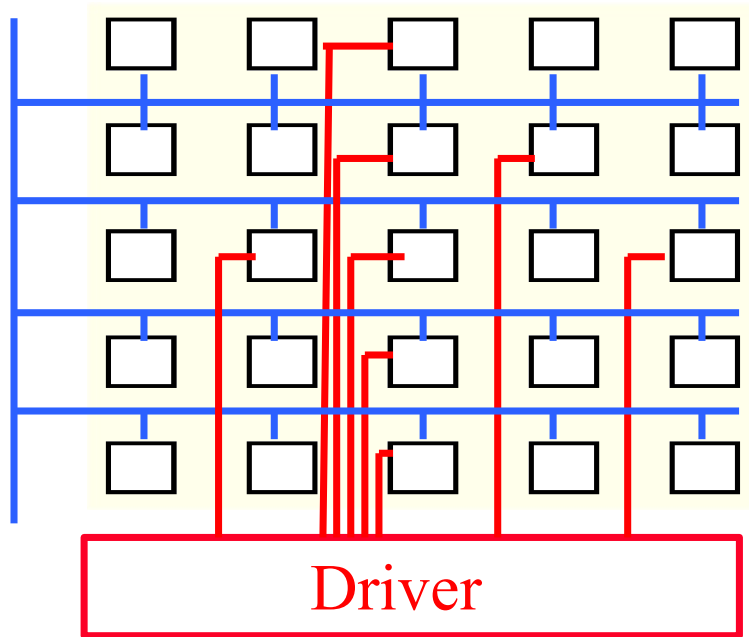
# N x M Matrix



- For  $M=480$  rows, a peak luminance of  $10^5$  cd/m<sup>2</sup> is needed to obtain an average luminance of 200 cd/m<sup>2</sup>.

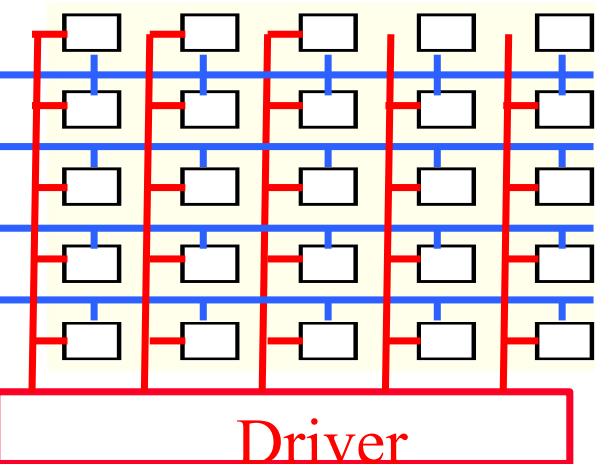
# **Active Matrix OLED Display**

# Matrix Addressed Display



Addressing is done row  
by row

## Main Problem with Passive Matrix



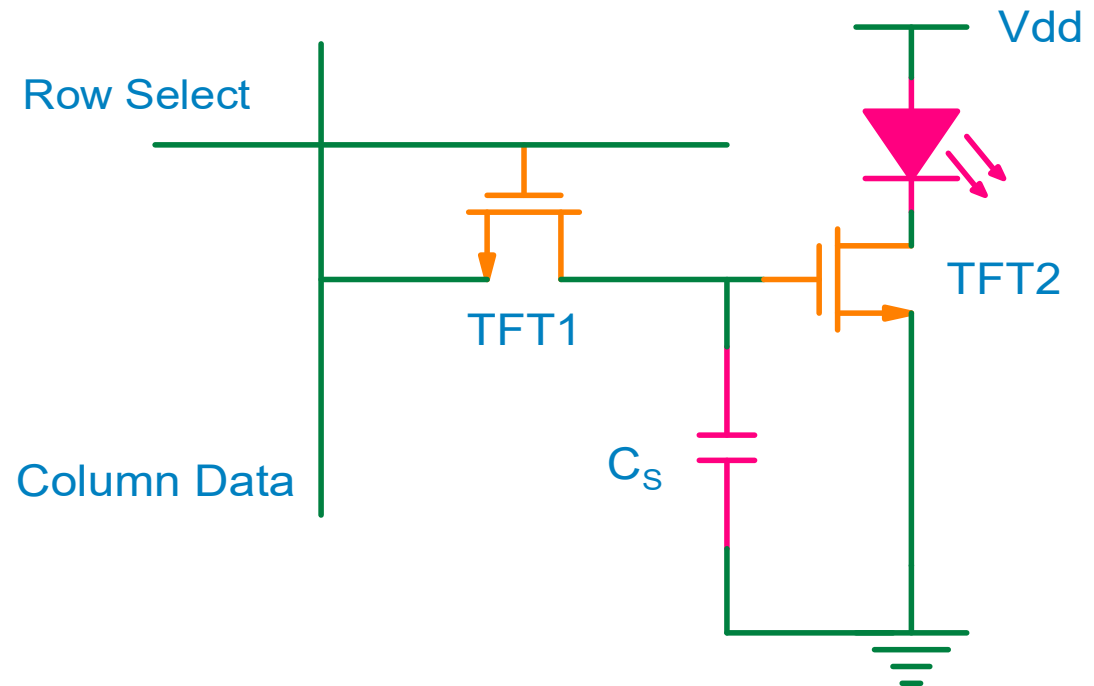
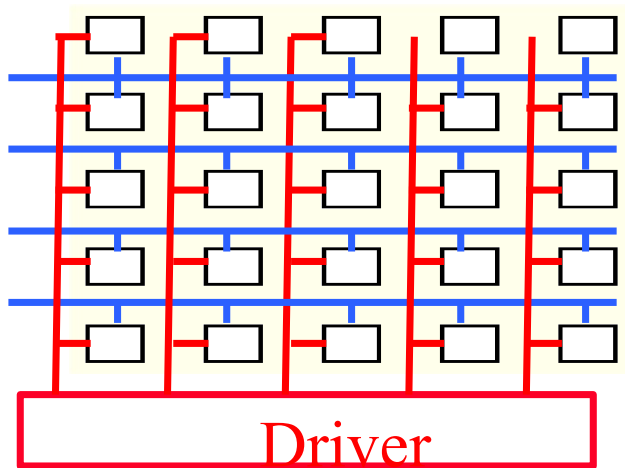
Resolution =  $1024 \times 1024$  ; Brightness =  $200 \text{ Cd/m}^2$

$$\begin{aligned}\text{Peak brightness from OLED} &= 1024 \times 200 \\ &= 2 \times 10^5 \text{ Cd/m}^2\end{aligned}$$

**Reason :** When we go from row  $R_j$  to the next row  $R_{j+1}$  the OLED in row  $R_j$  switches OFF

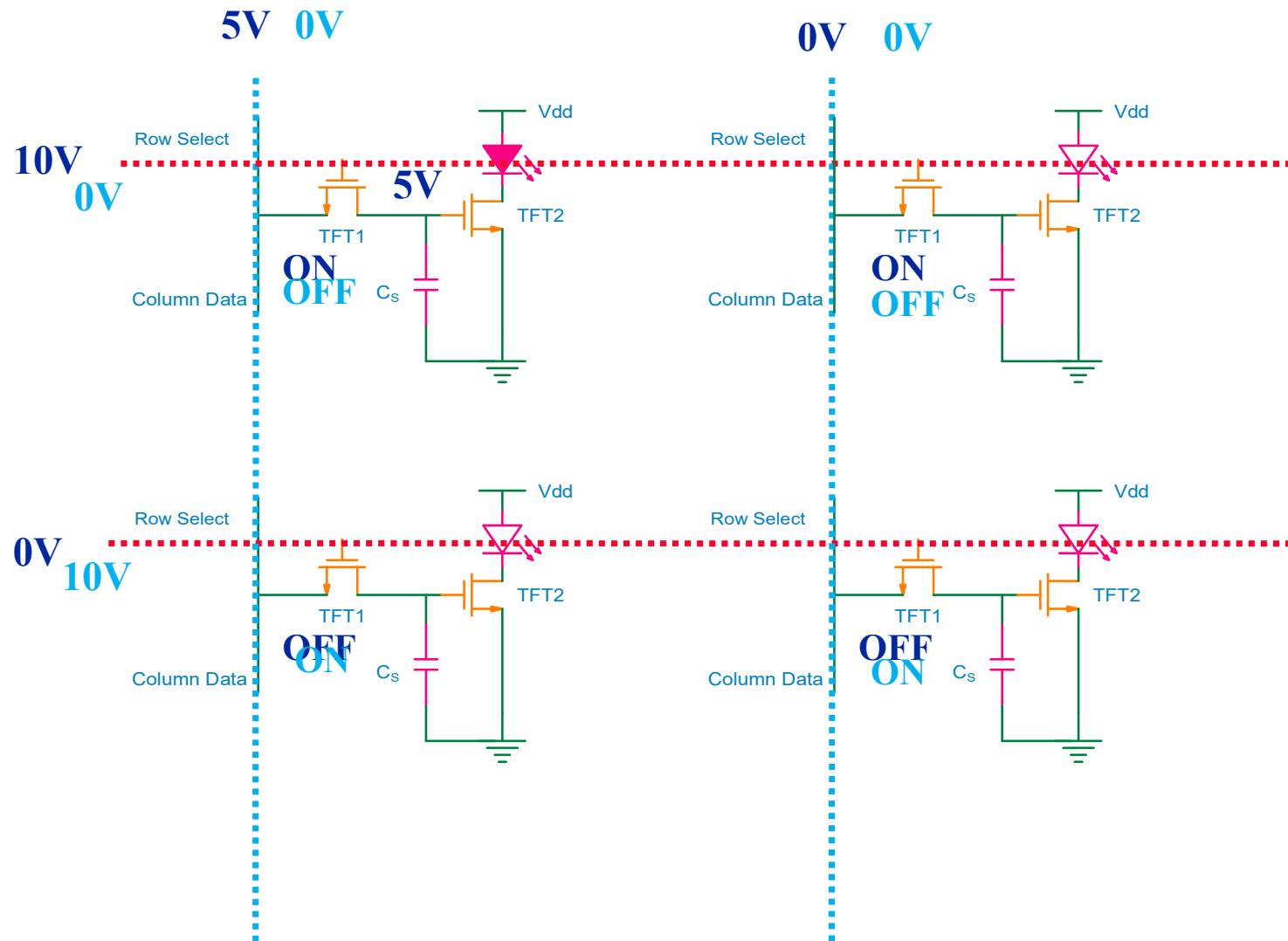
**Solution :** Keep the OLED ON even when it is not being addressed

# Active Matrix OLED Pixel





# AMOLED Panel



# One Pixel

